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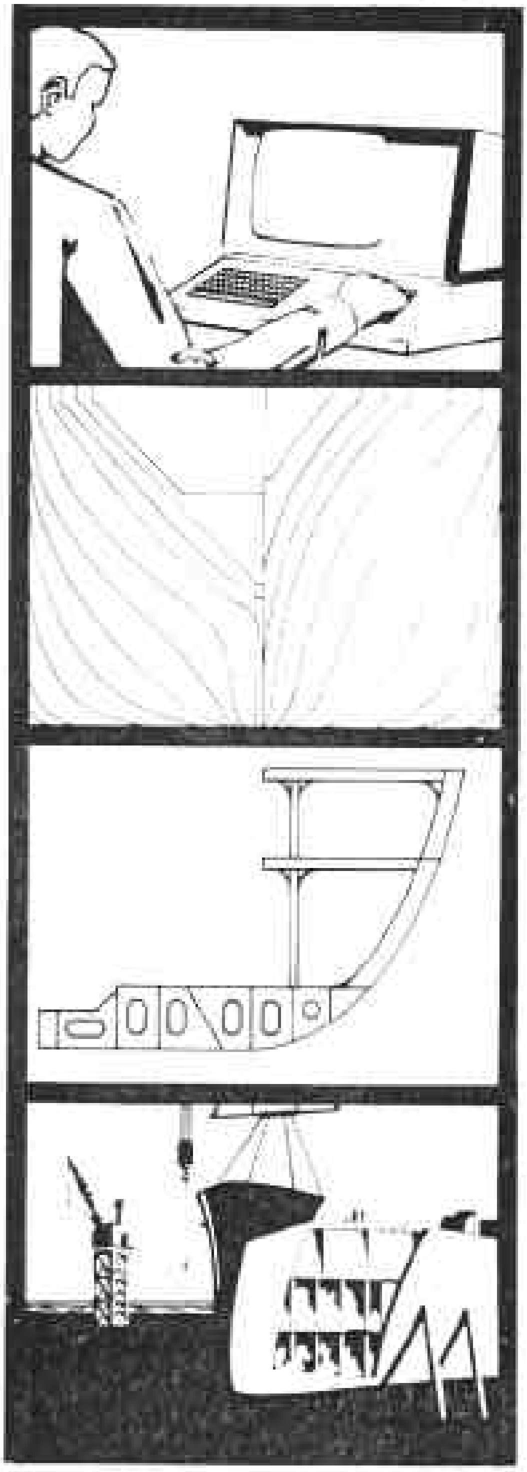

R ESEARCH
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IN
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DATA PROCESSING TRENDS AT ITALCANTIERI: PRESENT SOFTWARE PRODUCTS AND FUTURE PLANS

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1. OVERVIEW OF ITALCANTIERI

Today ninety per cent of the Italian shipbuilding industry is nationalized and is controlled by FINCANTIERI, a,holding of the IRI Group. This represents the biggest shipbuilding and shiprepairing organization within the area of the Mediterranean sea.

During the 1960's FINCANTIERI undertook a complete review and overhaul of Italian shipbuilding, with the objective of producing a new efficient and competitive organization. As a result of a series of studies which took place at that time, the decision was made to create a single shipbuilding company, with a size and structure capable of allowing:

- the development of products of a uniformily high standard, which were to be competitive within the market place;
- wide use of centralized research and development facilities during design phase;
- specialization within each shipyard in production of particular kinds of ships;
- use of advanced production technologies and automation of production itself.

The final result of FINCANTIERI's review was the creation in 1966 of ITALCANTIERI, through the merging of three old Italian Shipyards, at Monfalcone, Genova Sestri, and Castellammare di Stabia. These tree yards remain today the primary production centres of ITALCANTIERI. A further two yards, - Muggiano at La Spezia and Orlando at Livorno - which also belong to the FINCANTIERI Group - are operationally and technically associated with ITALCANTIERI.

The headquarters of ITALCANTIERI are located in Trieste, but the three shipyards are situated at considerable distances from the headquarters. Monfalcone is the nearest, being twenty miles away, Genova

ITALCANTIERI'S YARDS LOCATION

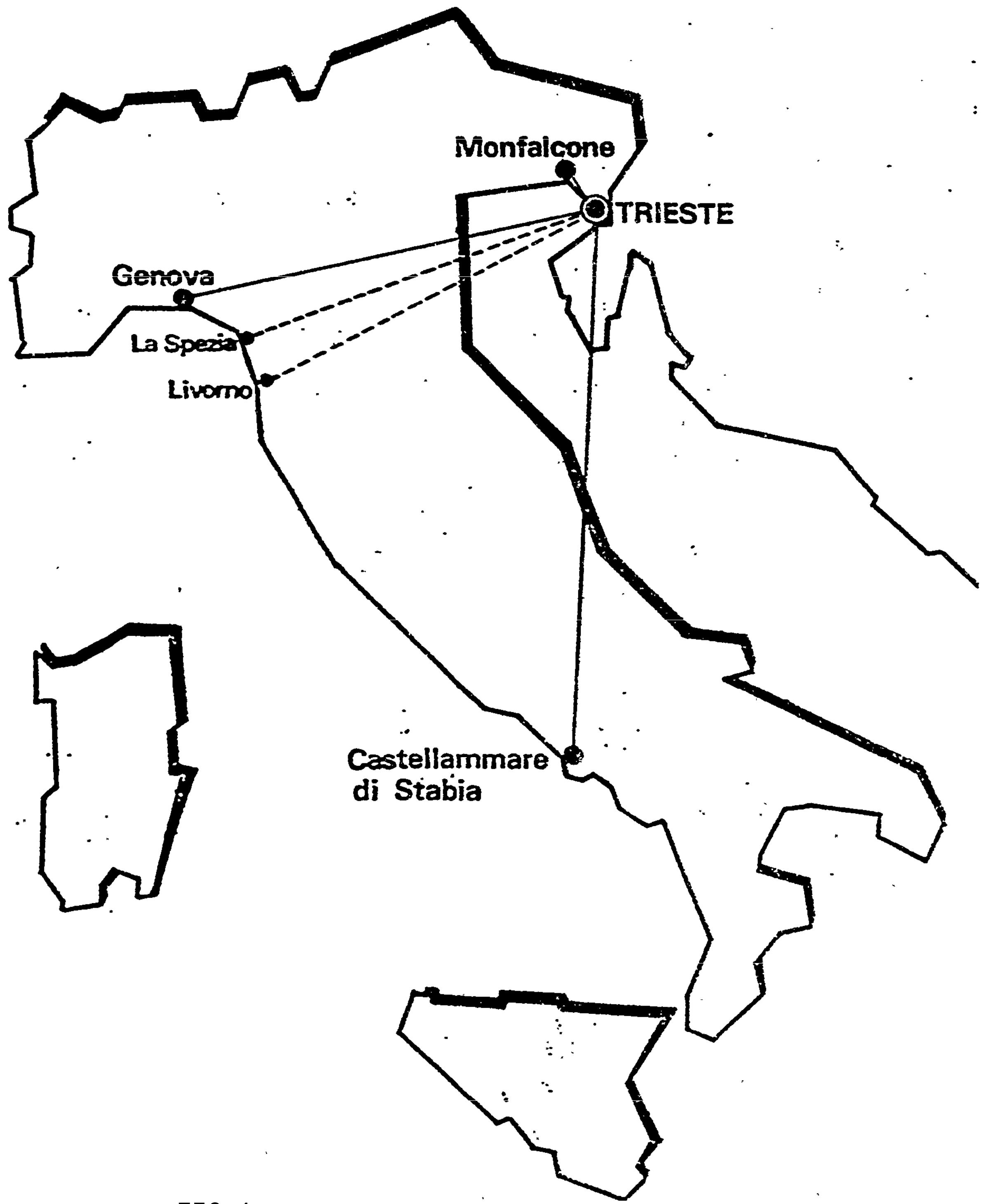


FIG:1

Sestri is about 400 miles, and Castellammare di Stabia, near Naples, is 750 miles away. (See Fig. 1).

The production capacity of the three shipyards is over 1.5 million dead-waight-tons (d.w.t.) per year. This comprises all types of ships, both merchant and naval: tankers up to 350.000 t.w.t., bulk and ore/oil carriers, cargo ships, container ships,- passenger, ferry, refrigerator, Liquid Natural Gas vessels, etc.

ITALCANTIERI now employs about 11,000 people.

2. GENERAL PHILOSOPHY OF ORGANIZATION

At the time of its foundation, ITALCANTIERI faced a number of managerial problems, of which the main were the following:

- number of staff at each of the three shipyards, related to the respective peak production workload, was too high for the new organization;
- design and workshop documentation standards, organizational approach to the job, departments dealing with external entities (such as classification societies, ship-owners, and suppliers) were so different that mutual co-operation was virtually impossible.

ITALCANTIERI decided that the solutions to the problems deriving from the merging could be achieved through the application of three general principles within the new organization. These were:

- centralization of technical and administrative functions;
- establishment of Methods Offices in each major department;
- recognition of the critical role of DP, and the decision to invest resources in its exploitation.

Centralization

The creation of ITALCANTIERI from the three existing shipbuilding firms was accompanied by the decision to establish, at the headquarters in Trieste, centralized departments responsible for general scheduling, sales, finance and accounts, design and purchasing. This centralization inevitably brought about certain problems in communications. These were anticipated by ITALCANTIERI, but it was felt that the advantages conferred by centralization far outweighed any disadvantages that would arise. The main advantages were:

- the merging and consequent augmentation of experience of technicians coming from different yards;
- the ability to distribute the total workload evenly over the work force available, avoiding peaks and troughs at a particular yard;
- more efficient and effective co-ordination and control of the functions of the whole organization;
- creating of a structure more amenable and receptive to improvements and innovations in working methods and technology.

Methods

In each of the following major departments within the new organization a Methods Office was set up:

- basic design;
- detail design;
- production;
- personnel;
- finance and accounting;
- each shipyard.

These offices were responsible for the improvement of procedures, the development of standards, the study of new production technologies,

and the definition of new facilities and plants. (Altogether more than 100 people are involved in these Methods Departments today).

DP Development

Within the new organization the role of the DP department was given a primary importance and significance. From now on it was to include not only the achievement of minor costsavings and timesavings in the production and design functions, but would operate as an influence throughout the organization in promoting a rigorous critical analysis of every job done and the methods used to do it. The objective was to encourage, and almost to force, the development of improved procedures and methodologies.

Today the personnel assigned to development of new systems number nearly 200 employees: 60 are analists and programmers and the remaining are users directly involved in the systems definition and development.

3. PRINCIPAL CHARACTERISTICS OF THE D.P. SYSTEM AT ITALCANTIERI

The peculiar structure of the Company allows a considerable degree of rationalization of some functions on one side, but on the other side causes some specific problems as far as design and workshop documentation are concerned.

And particularily the latter must be taken care of in its smallest details so that the shipyard can be completely independent and does not need further work from draftsmen and engineers.

For this reason D.P. systems have received the utmost care as for the aspects of exactness and exaustiveness of information.

This information system was not conceived as a single entity, but consists of a number of systems, started at different times during the

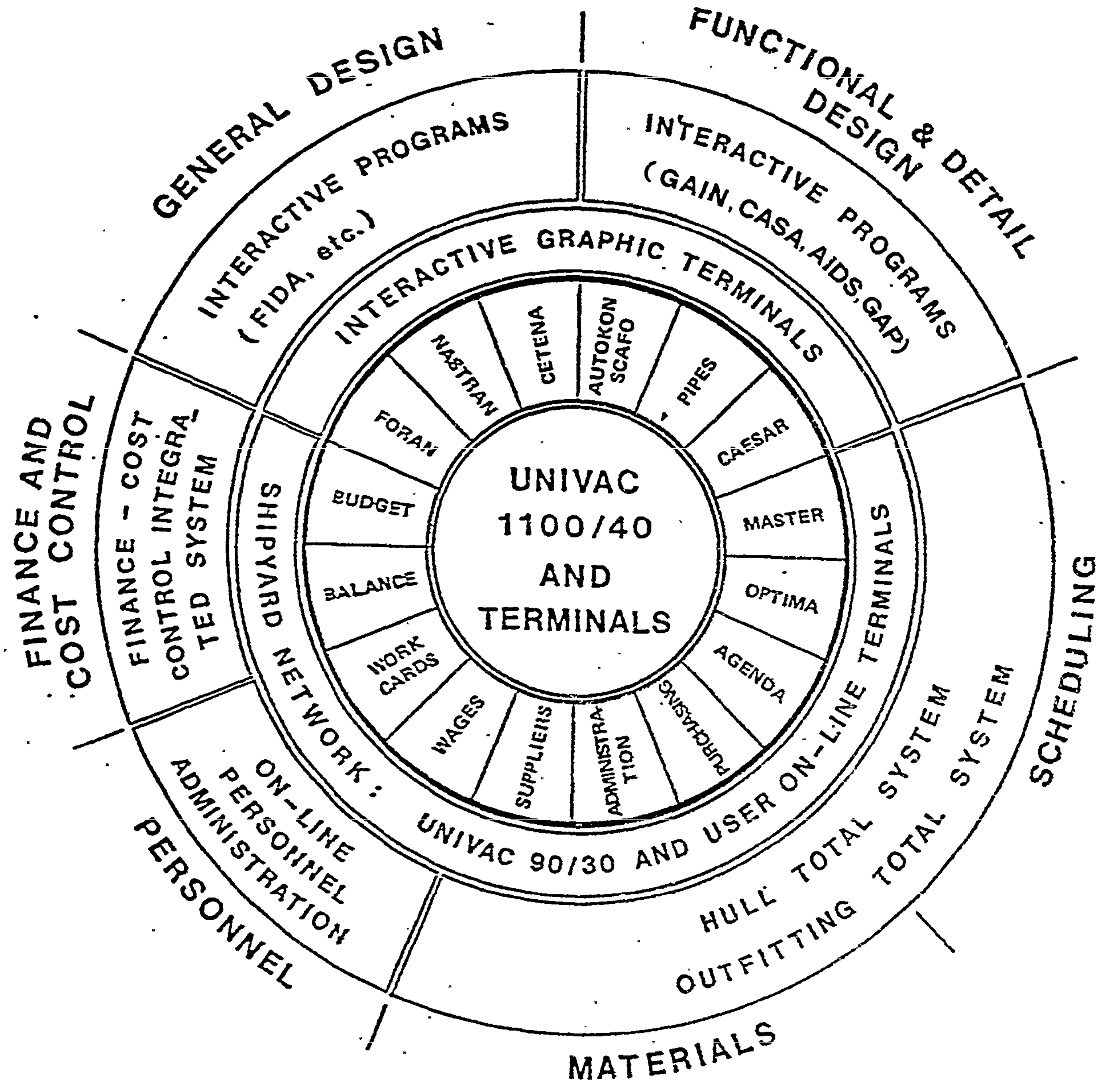

GENERAL DESIGN
INTERACTIVE PROGRAMS (FIDA, etc.)
FUNCTIONAL & DETAIL DESIGN
INTERACTIVE PROGRAMS (GAIN, CASA, AIDS, GAP)
INTERACTIVE GRAPHIC TERMINALS
NASTRAN
CETENA
AUTOKON SCAFO
PIPES
FORAN
CAESAR
BUDGET
MASTER
BALANCE
OPTIMA
WORK CARDS
AGENDA
WAGES
SUPPLIERS
ADMINISTRA-TION
PURCHASING
UNIVAC 1100/40 AND TERMINALS
FINANCE AND COST CONTROL
FINANCE - COST CONTROL INTEGRA-TED SYSTEM
SHIPYARD NETWORK: UNIVAC 90/30 AND USER ON-LINE TERMINALS
SCHEDULING
HULL TOTAL SYSTEM
OUTFITTING TOTAL SYSTEM
PERSONNEL
ON-LINE PERSONNEL ADMINISTRATION
MATERIALS

FIG. 2

past years, all of which were designed to serve the overall objectives of the company as a whole.

The system is still not complete but continues to develop, becoming increasingly more comprenhensive in its power and scope. As it expands the need for computer hardware increases, to provide additional on-line facilities and computer processing time.

The range of applications described in the following paragraphs runs on a considerable network of interactive and batch terminals based on an Univac 1100/42 at the central processor, satellite 90/30 processors at each of the three shipyards, a Kongsberg RJE with two drafting machines, on ADAGE GS/340 interactive graphic terminal with two consoles, a PDP 11/70 with an ADAGE GP440, TEKTRONIX 4014 and alphanumeric terminals at the detail design department and, at last, several alphanumeric terminals directly connected with the main frame for administrative applications.

3.1 Outline of Italcantieri D.P. Information System

The application software modules constituting the system are ‘shown diagramatically in Fig. 2.

The figure clearly shows how:

I) all design and administration activities are covered by D.P. systems;

II) some systems (like FORAN, NASTRAN, AUTOKON, OPTIMA) were purchased abroad either in order to overcome initial software shortage or because in any case home development of the product would not have been profitable at that time;

III) the Company has spent a considerable amount of energies in the last years in order to develop interactive applications in the field of design, and real-time and data base oriented activities applications in the fields of administration and control of materials.

As it is not opportune to make now a detailed description of the single systems, mention will be made of their respective utilization fields and then a detailed description will follow of four systems which are the most interesting from the point of view of mutual integration which will successively lead to the realization of a new generation of Italcantieri information system especially in the technical field.

General Design

FORAN - a design system based on the mathematical definition of the hull form.

CETENA - for hydrostatical calculations, and checking loading and unloading conditions.

STRUCTURAL ANALYSIS - using the packages NASTRAN, SESAM and FRENAT.

AUTOKON 74 - for the generation of parts as far as the internal structure in concerned.

SCAFO - for structure definition, drawings, generation and preparation of documents and technical information for hull production.

PIPES - for detail design and workshop documentation for piping production.

CAESAR - for the design of electrical plant.

GAIN - for interactive part definition and nesting.

CASA - for interactive ship accomodation.

Scheduling

MASTER SCHEDULE - for determining the time of the major events in management of ship construction.

AGENDA - for timing and control of detail design Dept. and shipyard activities.

OPTIMA - as basic software for the management of network techniques.

Materials

PURCHASING SYSTEM - for order handling and control.

ADMINISTRATION - for periodical follow-up of the warehouse and materials accounting.

SUPPLIERS - for materials suppliers book-keeping.

Personnel

WORK CARDS - for the handling and accounting of Work Cards.

WAGES - for wage calculation and personnel administration.

Finance and Cost Control

BUDGET - for monthly check of cost of each ship under construction.

BALANCE - for handling all legally required auditing tasks.

3.2 HULL, SCAFO, GAIN, CASA, PIPES SYSTEMS

The reasons for the presentation of these four technical systems as indices of the level reached within Italcantieri are that we can prove that utilization of these systems is followed by positive results and that they cover more than 90% of all design activities; moreover these systems will constitute the basis of the new integrated design system which is being developed within Italcantieri.

HULL System

At Italcantieri, the whole production cycle for hull construction, from general design to the definition of each elementary component, is performed with an intensive use of specialist skills and production facilities. Consequently, Italcantieri's shipyards are today equipped with the most advanced tools available for material handling and working.

The technical and economic importance of hull construction has for

many years forced the Company to concentrate its own specialist resources in the development of DP systems that are considered essential tools in order:

I) to guarantee competitive products of the highest quality;
II) to rationalize the manufacture of these products.

In the development of such systems the Company has not hesitated to purchase packages from other Organizations whenever these could allow the attainment of the highest possible standards in the shortest possible time.
The computerized systems are operational today in the area of:

- Hull Design.
- Hull Production.

The system for hull design is principally beneficial in those areas of the process requiring creative development, relieving the designer of the need to carry out complex and sophisticated calculations and drawings manually, and of course reducing the time taken very considerably.
The system for hull production has made the greatest impact in the detail design area, where so much of the work is repetitive and where it is necessary to produce large amounts of printed output in different forms. Such a system, which is the very foundation of a rational use of materials and machinery, allows Italcantieri today to achieve the following goals:

- establishment of a logical and automatic connection between executional and detail design and production;
- automatic preparation of supports- for production processes;
- definition of all data concerning raw or semifinished materials;
- definition of the elementary components and their assembly links;
- definition of all basic data required for efficient production control.

SCAFO system

The system has been developed and implemented at ITALCANTIERI since 1972. In 1976 it was also implemented at CNR, and it is used for services by ninety per cent of small yards within Italy.
It is a computer aided instrument dealing with hull structure definition, drawing, generation and preparation.
It has replaced mould loft and part of production office activities, by integrating them with those of technical office.
As far as the structure definition and drawing is concerned a special version of the system has been linked with AUTOKON system under the name of AUTOKON 79.
Philosophy and related functions are briefely described in appendix A.

GAIN (Graphic Advanced Interactive Nesting)

The GAIN system was developed by ITC to solve nesting activity problems, which are critical owing to the high quantity of resources required before the workshop starts its operations.
The system works mainly on an ADAGE GS/340-interactive terminal with some module on the host computer. The modules on host computers perform the following functions:

- retrieval of geometrical description of part coding system from the data base;
- preparation of a booklet containing drawings of all called parts;
- management of data base containing final and intermediate results of nesting operations;
- storing into the material data base of all necessary information for plates purchase;
- transfer of preliminary data and results to and from remote interactive stations;

preparation of workshop drawings, documents, and paper tape for NCFCM.

On Adage side GAIN provides the following interactive modules:

management of local data base containing preliminary data and temporary results;

part definition;

part positioning;

cutting path definition;

drawing annotation.

By using traditional procedures and assuming as a basic datum a production of 3000 nestings per year, the traditional nesting activities required about 16 draftsmen who would on the average produce a nested plate per man every 8 hours.

To complete a working batch containing an average amount of 20 nestings, the total elapsed time was about 2-3 weeks.

At present all nestings produced for the company's shipyards are carried out interactively by only two persons.

The average time for each nesting is less than 1 hour of which about half an hour is spent for all non interactive activities.

From the point of view of preparation of workshop documents and of paper tape for the numeric control machines, the result is even more interesting as all operations on one batch are thoroughly performed in 2-3 days.

The system is at present available in the following alternative options:

main frame: UNIVAC 1100, IBM 370

interactive station: ADAGE GS/340, PDPll, plus ADAGE GP400

parts' data base: AUTOKON system, any other system

(for a deep description of GAIN see: "NEW CONCEPTS AND D.P. SYSTEMS ARCHITECTURE IN HULL DETAIL DESIGN", ICCAS 79).

CASA (Computer Aided Ship Accomodation)

This system produces drawings of high quality, bill of materials, orders, and lists for fitting of accomodation.
The CASA system allows very easy handling of data base and modification of rules and standard items, without altering operative programs. The draftsman can handle the program in batch mode for primary input and use interactive mode for corrections and updatings. C.A.S.A. system has three logic modules:

description of standards, this operation is handled in batch mode. In this case the input concerns standard materials description and general selection rules. This kind of data are stored into the data-base of the system; drawings and lists are also provided.

description of ship design data, from design drawings the main data are loaded into the computer for further processing.
All the operations of this phase are considerably simplified (thanks to a particular "user-oriented" language) and do not require specific knowledge of DP. Relevant output drawings will constitute the basic layout of accommodation.

interactive automatic design, from description of construction data and standards, with the aid of interactive functions of C.A.S.A. system, "automatic" and "interactive" designs are developed. Automatic design, which foresees data processing for each constructive detail, is completely handled in its initial phase in batch mode. Interactive design allows corrections and modifications of data and standards, with immediate feedback, thus giving the operator the possibility of a quick and easy communication with the computer.

In details, the system deals with:

- accomodation basic plan
- accomodation basic plan with rooms numbering
- wall panelling plan
- wall panels nesting booklet
- materials withdrawal notes
- summaries of material requisition orders
- pallets subdivision
- door plan
- coamings plan
- joints plan
- furniture plan
- ceilings plan.

The advantages achieved by the system can be summarized as follows:

<u>reduction of work</u>: automatic and complete preparation of bill of materials, of workshop documentation and drawings, has allowed a reduction of manpower from 6000 to 1500 hours per, ship.

<u>reduction of calendar time</u>: automatic processing and interactive check and correction, in addition to dramatic reduction of time for the drawings, have reduced the calendar time from 12 to 5 months.

<u>PIPES (Program for an Integrated Pipes Engineering System)</u>

At Italcantieri general design and production procedure for pipes is characterized by:

definition of functional diagrams
definition of piping runs
issue of operational documents and of the bills of materials
manufacturing of piping elements
erection of piping elements.

It must be borne in mind that the piping functional diagrams correspond directly to the individual ship's plants and services. The production procedure for the piping calls for different exigencies, v12:

- the workshop documents for the pipeshop must allow the most efficient loading of the machinery available, which is organized in a highly automated line
- the workshop documents for the erection must allow parallel progress in the building and assembling of the hull and outfitting elements.

The goal reached by Italcantieri was the harmonization of the present procedure of design, mainly oriented to packages of pipe-lines, with the pipeshop requirements. That is, costs were minimized and optimum utilization of raw materials was achieved.

It is, however, necessary for production process that the workshop documentation and the bills of materials refer to work "flows", into which the yard workshops are organized. In relation to the various methods of production, the main types of workflows are:

- numerical cold bending
- traditional cold bending
- composition bending (sectors and prefabricated bends)
- hot bending.

Further, the working documentation contains the instructions referring to the store, which the raw material has to be drawn from, and to the destination (pallet) of the finished elements, with reference both to treatment following working and to final destination of the various assembly groups (units, blocks, on board),

About 50% of the pipe work at Italcantieri is concentrated on the automated production line, which consist of:

- an automatic store, where approximately 7,000 bars of pipe are kept;
- an automatic cutting station;
- an automatic spot welder for plane flanges
- an automatic flange welder
- a pipe finishing (grinding) station
- a numerical control pipebending machine.

Information control for automatic production line is provided by the computer.

PIPES consists of three fundamental stages:,

storing of general technical data: in a preliminary stage, the loading of the Data Base is provided for; the Data Base contains:

- utilization criteria and technical description of standardized materials for the piping field;
- piping specifications for a particular ship;
- workshop organization and equipment existing in the various yards, with regard to the various production methods.

processing of the assembly groups: after the piping runs have been defined, data pertaining to the various assembly groups are filled on input data sheets, where working conditions and general geometric characteristics of each piping element are indicated.

On the basis of this data, and after a syntactical and logical check, the computer provides for:

- completing the data supplied on the basis of standards and ship's specification, with the definitive list of needed materials;
- defining, also on the basis of the ship's specification and informa tion on workshops organisation, the method of piping elements manufacture, and the operational parameters for bending itself. It also produces paper tapes for the numerical control bending machine;

- producing a mounting booklet consisting of symbolic sketches (produced by a line printer) of the pipes composing the group, and of a list of the mounting fittings;
- storing the information gained up to this point. in the Data Base.

processing of the workshop booklets: working "lots" for the pipe workshops are defined taking into account the quantity of the pipes in the processed zones and their mounting method. Starting with the information contained in the Data Base, the computer provides for each individual flow of work:

- documentation for withdrawal of materials needed for manufacturing;
- "cutting plans", looking for the lowest possible scrap;
- operational supports for numerical control machines;
- sketches for traditional working and finishing platform, produced by Calcomp plotter;
- summary documentation for co-ordinating progress of work and handling of the lot.

The above procedure is integrated with the material handling subsystem developed at Italcantieri.

4. PRESENT TRENDS OF DEVELOPMENT

In the last years a deep change has been taking place in the final user's attitude while approaching D.P.

As the number of applications was progressively growing and as their presence became more and more important in view of attainment of final documentation, the user was more and more feeling the necessity of direct control of processing.

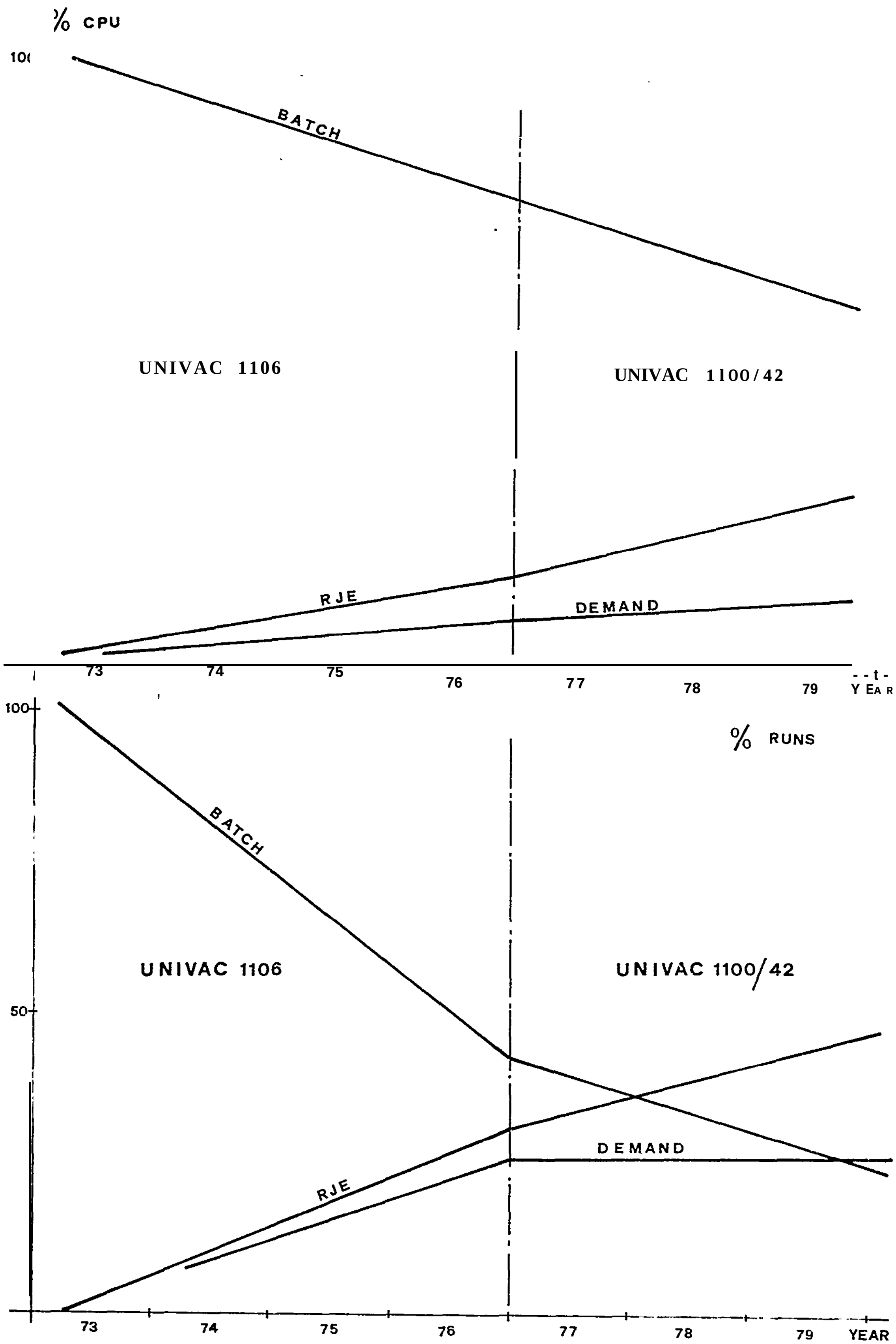

% CPU
100
BATCH
UNIVAC 1106
UNIVAC 1100/42
RJE
DEMAND
73
74
75
76
77
78
79
YEAR
100
50
% RUNS
BATCH
UNIVAC 1106
UNIVAC 1100/42
DEMAND
RJE
73
74
75
76
77
78
79
YEAR

FIG. 3

This irreversible tendency was the cause and the consequence of the introduction into the market of peripherical high processing capacity offering both availability of applicative software, and easy interaction with main frames.

The passing from centralized to de-centralized processing is clearly illustrated by the two diagrams of fig. 3.

Both diagrams show a constant tendency to direct use of processing capacity by the user. This tendency is even more clear if an analysis is made of data regarding the percentage of runs started by RJE or time - sharing terminals in comparison with traditional batch.

Particularily difficult is to represent, from the numerical point of view, the datum expressing the evaluation of percentage of stand-alone processing capacity.

This is due to the fact that, within Italcantieri, installation of stand-alone computers was foreseen along with creation of completely new procedures or with transfer of activities not particularily important from the point of view of central computer utilization.

In line with the experience developed within Italcantieri the main reasons underlinyg these tendencies are:

Technical Factors

Generally, the performance of the systems is judged, from the user's point of view, on the basis of the number of transsactions per second and response time. Obviously, in this case, there is an increase in performance of many parallel centers as compared with the performance of only one main frame having the same global capacity. This is due to the higher probability to dispose of processing capacity particularily when the systems' utilization index is high.

A marriage between computers and communication means is at the basis of the most advanced system. The weak point of this union, however, is represented by the lines.

Both because of speed and reliability problems. The limitations relevant to the communication push to move the processing units near to the interested users.

The centralized systems, when exceeding determinate dimensions, cause heavy problems. Examples are the complex and sophisticated operating systems, of difficult maintenance, necessary to cope with different needs and with the remarkable complications from the operational point of view.

Economic Factors

The progress of the computer technology led to increase of performance associated with a decrease of costs.

Nowadays, the cost of the computer is, however, only a component, very often not the main one, of an extremely difficult choice.

For example, we notice that the costs of the means of communication, a basic component of all the present processing systems, show a limited trend towards reduction. Therefore we trie to economize them through a higher decentralization. Moreover the hardware investment, that is necessary today for new systems, is only a part of the needs. A big part of the investment is, infact, covered by the development costs of the applicative and basic software.

Specialization Factors

Many present applications are possible today thanks to the use of particularily specialized hardware with high specific performance that cannot surely be obtained from a single multipurpose computer.

Organizational Factors

The possibility of decentralization allows the construction of systems that are organically suitable to the various organizations with a high level of flexibility to cope with the diffe-

rent needs of the user, though respecting the co-ordination of the network.

Human Factors

The placing of the processing means in the different company departments is a decisive factor for the involvement of the user who is already prepared to manage the part of the system that directly interests his. functional area.

From what we have just said, it is clear that today the cost factor of the computer alone is not a decisive element of the DP choices. Infact, to design a data processing system is today a complex operation resulting mainly from the matching of the users' needs and technological development:

At Italcantieri, the above mentioned factors have led to the installation (obviously besides main-frame) of the whole hardware range utilized for distributed data processing:

Data collection

Satellite graphic system

Data Entry / Data Capture

Dedicated interactive graphic system

Computers network

Compound satellite system for design and production.

5. FUTURE SOFTWARE PRODUCTS OF ITALCANTIERI

What has been explained up to now had the purpose of emphasizing and explaining the following three points:

I) Italcantieri had to devote particular care in designing its information system on account of its specific environmental difficulties (three yards located very far from one another

having different traditions and working methods).

II) Even-if a deeper analysis has been made of applicative software operating in the 'technical area, the intention was also to clarify how integration of application modules follows mainly vertical, not horizontal lines: integration in the systems, not integration among systems.

III) User's requests, hardware's development and acquisition of all D.P. advanced techniques (Data base, real-time, graphic interaction) direct the Company towards a new software generation.

Always within the field of applicative technical software, the bases of the new system can be identified as follows:

software and hardware modularity

modularity in I/O media

software transportability

processing capacity distribution

horizontal integration among systems.

Undoubtedly it can be stated that very modern firms could today be equipped with all D.P. instruments which cover more or less all company's fields.

What has not yet been achieved but should constitute an aim to be pursued is:

I) a simplification of logical flow of information which implies a consequent organizational improvement;

II) a considerable reduction of execution times of design and administrative operations;

III) a reduction in human resources necessary on account of constant increase in cost of personnel owing to the fact that, even when the number of people remains the same, there is a world tendency towards reduction of working hours.

In line with the principal aims which are pursued and with the main characteristics that the new system is required to have, Italcantieri has started - and as for hull design completely defined - the analysis and the functional specifications of two new systems:

AIDS (Advanced Interactive Design for Ships)

GAP (General Arrangement Plan).

which will unify all functions of systems now operating that were already described in details.

AIDS and GAP whose development will be, wherever possible, realized by successive parallel steps, will constitute one all-inclusive information system for design and Workshop documents and for preparation of bill of materials both for hull and outfitting design.

AIDS, the system which grants continuous definition and storage of all data contained in the classification drawings, will be formed by a series of independent modules connected to each other by a data base containing:

the topological description of the hull structure that means storing of all logical relations among hull structure items in the data base;

the assemblying sequence, explicitly or implicitly defined during design operations, that needs to automate the assemblying workshop documentation;

the physical description of the structure for material ordering and handling.

The accurate up-dating of this information in the data base will allow transfer of a tridimensional model to GAP which is the module specifically programmed for piping design.

GAP, the flexibility and simplicity of hull design system (SCAFO DSI) utilization already allows Italcantieri to supply the office dealing

with detail design of machinery, piping and electrical plants arrangement, with all the drawings obtained as any section of the structure.

The new philosophy of the information system for design will allow a more rational utilization of information generated by hull detail design office.

This will be accomplished, thanks to the modularity foreseen both in hardware and software configurations, in two ways:

I) contemporary utilization of only one stand-alone station by hull and outfitting designers;

II) crossed utilization of data bases located on more then one specialized stand-alone station.

The GAP data base will have to be synchronized with the AIDS data base only at the level of physical and topological description of outfitting so that the designer can have continuous availability of the hull structure for which the system he is designing must be fitted.

The principal modules of the GAP system will allow:

definition of functional schemes;

topographical positioning of plants;

overall coordination of various plants;

realization of executive drawing and materials lists and flow.

6. DELIVERY PLAN FOR FIRST MODULES

Realization of the two AIDS and GAP systems, which will have to be complete with minor operative modules (I/O for structural analysis, hydrostatic and hydrodinamic calculations, electric system design, etc.), will require a considerable use of resources which will mostly leave their traditional working environment (main frame) in order to

develop products on minicomputers with intensive use of conversational graphical and alphanumerical techniques.

The delivery plan of the first modules is founded upon the two systems already in operation and present on t-he -market SCAF0 and GAIN.

The most interesting operative skills of the two systems can be summarized as follows:

SCAFO: easy and complete description of all hull internal structures, possibility to obtain any type of section (classification drawing), rich workshop documentation, ordering and material handling.

GAIN: part definition, part positioning, cutting path definition and drawing wording.

In line with the above mentioned purposes, the first deliveries for the AIDS system will deal with:

I) re-writing the whole SCAFO system for minicomputers with intensive use of graphical and alphanumerical interaction;

II) final preparation of the parts automatic generation module which, on the ground of the hull topological description, will allow elimination of boring traditional methods of part coding;

III) integration of GAIN system to data base supporting modules mentioned at point I and II, so that, in addition to possibility of automatic part generation, the GAIN part definition module, which also allows partial modification of parts (no matter how they were obtained), will be available;

IV) points I, II and III, whose completion is scheduled within the end of 1980 will also include a module for mesh generation and for I/O visualization in the structural analysis field.

Realization of this module will fully develop potentialities offered by the software mentioned at point II).

Following the policy of maximum processing de-centralization and considering that the detail design offices often need to make non

sophysticated structural calculations, suitable software tools will be implemented on the peripherical computers.

1980 will be mainly dedicated to the realization of what has been outlined above so as to enable the Company to enter the market with the first turn-key configurations which is specifically designed for shipbuilding industry, and not deriving from awward mixings of old and new technologies.

As for realization plan of GAP, relevant analysis is scheduled in the first months of 1980 and is to be followed by functional specifications and detail specifications.

In the meantime, as initial delivery of modules also in the outfitting field, conversion will be performed of the CASA system on minicomputer.

Without describing the foreseen hardware configurations in details, the Company has the availability of the most efficient 16 and 32 bits machines.

A P P E N D I X A

SCAFO system: a computer aided instrument in steel structure definition, generation and preparation

INTRODUCTION

The most crucial problem in shipbuilding is nowadays: how to tackle the reduced calendar time.

Hull process, from preliminary design to assembly, represents the most critical activity to reduce contract signing-to-delivery times.

Conventional methods even supported by some computer systems are, not suitable to meet these demands because they are very often mortified by the prevalent geometric definition of the structure or because some activities need to be carried out manually.

ITALCANTIERI had faced these problems since 1970. By that time some good software available in the market was bought and implemented, but it cove red only some application areas.
Hence the needs of extending the use of the computer, aimed to eliminate duplicated activities and at the same time to make it easy to perform parallel activities as much as possible.
Among the systems developed by ITC in technical applications a great deal of efforts has been devoted to develop the SCAF0 system, specific for definition, generation and preparation of hull structure.

MAIN GOALS ACHIEVED BY THE SYSTEM

When we set about to develop the system the many problems involved had been deeply analized.
It was clear that to be a successful system the following goals had to be reached:

1 - elimination of duplicated activities formerly performed both by the mould loft and by the detail design office as far as structu re definition, preparation and alterations are concerned;

2 - accomplishment of parallel activities in designing, definition and preparation of steel structure;

3 - full documentation for material handling and material processing at the workshop;

4 - full documentation for assembling, mounting, and erection of struc tural units;

5 - avoidance of redundant data over the different operational phases;

6 - hardware portability and easy links with other systems.

The foregoing points are achieved to day, thanks to the solution of the problems involved.

PHILOSOPHY OF THE SYSTEM

SCAFO system is characterized by some basic concepts which are peculiar for the representation and logic definition of the steel structure by the aid of the computer.

These concepts, introduced in D-P., mainly refer to the conventional methods which are familiar to the designer or draftsmen.

They can be summarized as follows:

a - a steel structure is a collection of single structures each of which is a collection of connected details;

b - a single structure spatially refers to a geometric surface and it is bounded by the structures it is connected to;

c - a single structure consists of a panel, stiffening, completed by holes, seams and inner contours;

d - detail's of a structure as far as thickness of plates, scantling and orientation of profiles have to be fully ed univocally defined;

e - representation of the structure has to be performed by a general point of view and not orientated to a specific type of ship;

f - description of the structure has to be based on low-level standars which meet every orientation or direction of the details;

g - asymmetrical structure even in presence of an asymmetrical body plan has to be dealt with;

h - avoidance of data duplication as far as structure definition is concerned;

i - data stored have to be the minimum necessary, consisting of geometry (how the structure is arranged) and topology (where the structure is located);

j - geometry is separated from topology, so that when alteration occours in the delimiting structure, it will continuosly effect the relevant structure, simplifying maintenance in taking care of design alterations;

k - on the basis of the logic relationship between structures and the minimum geometric data, the actual boundaries are generated each time they are referred to, so that output assures tha last geometrical solution;

l - output support has to be a result of highy quality of calculation and complementary information must be supplied at any time;

m - prints and drawings have to be clear and easy to be interpreted so that they are legible both by technicians-and workers;

n - output has to be supplied according to the demand of end users, yard installation, and practical procedures.

PARALLEL ACTIVITIES

Although the concentration of mould loft activities with those of the technical office has produced a positive influence in calendar time, the most relevant results have been determined by the capability of parallel operations during the accomplishment of different tasks.

As you can see in fig. l, usually, in hull process man-power was distribuited in a longer time because of the conventional procedure.

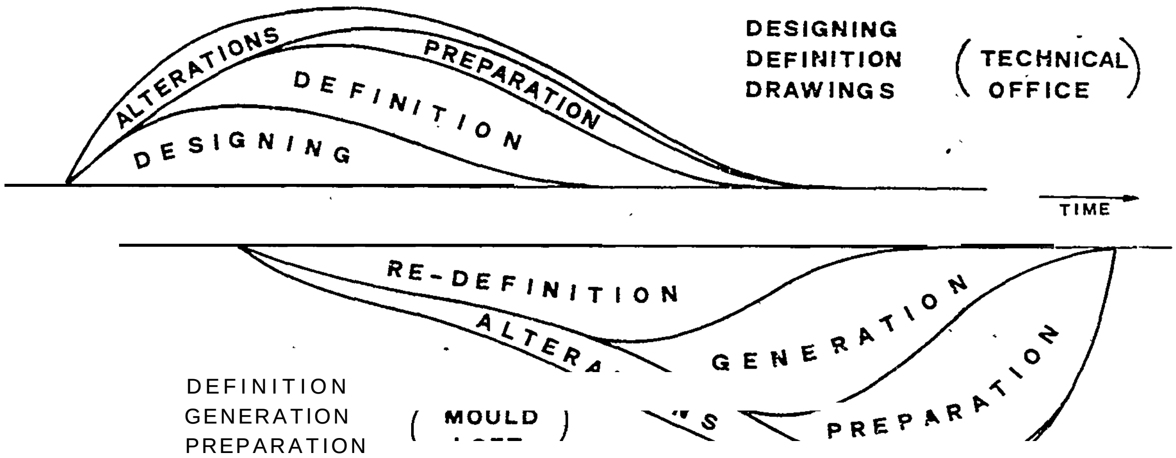


Fig.1

As a consequence there were two main phases which were almost duplicated by the mould loft. The first is structure definition and the second is work preparation. Besides alterations cause also duplicated work.

Today, thanks to the availability of adequate software, the procedure is different as you can see in fig. 2

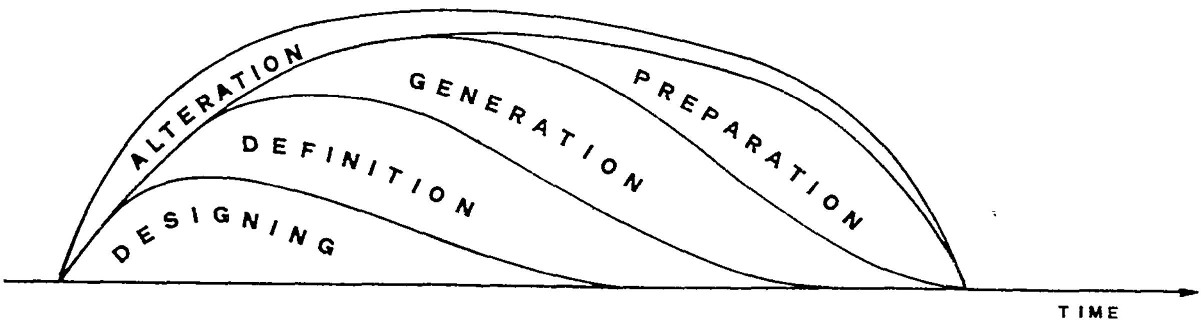


Fig.2

Apart from the relevant reduction, of duplicated work and bearing in mind the concepts described above (prevalent logic description of the structural model) many activities can now start in a phase which is advanced if compared with conventional methods.

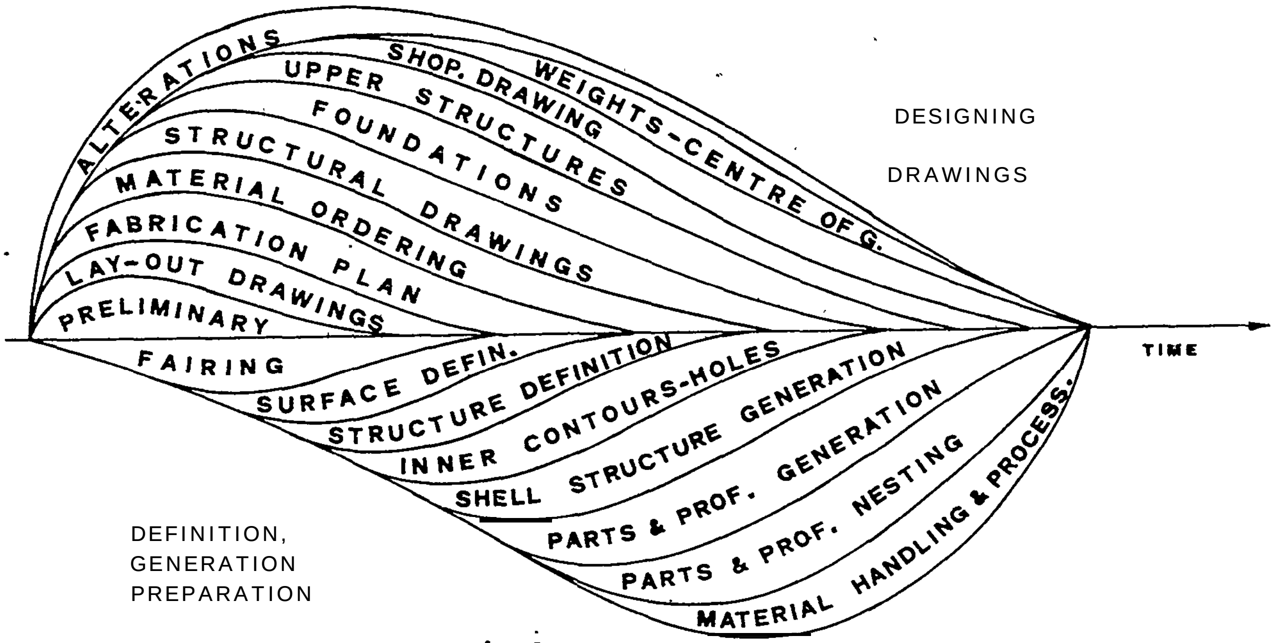


Fig.3

Structure definition can be initiated even though the actual body plan has not yet performed. This aspect is the most relevant factor because it influences, more or less, all the other activities.

BRIEF DESCRIPTION OF THE MODULES AND RELATED FUNCTIONS

Structure definition

Apart from body plan definition and loading, which are performed by FORAN or by AUTOKON BOF module, there are three modules of the system provided to handle and store the actual structure.

Transferring of longitudinal surfaces

The module can cope with any type of longitudinal surface either flat, curve, twisted, or a combination of the three geometrical conditions. Practically any typical surface can be determined and stored (unless it requires to be faired).
The module supplies the intersection points between the longitudinal surface boundaries and transversal plane in correspondence of transverse frames. Furthermore and for each transverse frame, ending points of every penetrating surface are printed.

Transferring of details at shell

The module stores the longitudinal seams and longitudinal profiles at shell.
It deals with any typical shell connection trace and for profiles the right web and face plate orientation can be indicated. Longitu dinal structures connected to the shell are automatically included from previous loading.
Further to the above, details like bottom and side tangencies of body plan, are stored by this module.

Transferring of inner structure details

The module stores profiles, seams, minor structures and connections concerning inner structure. All profiles and seams are reduced into a few family types upon their prevalent arrangement.
They are furtherly simplified by the conventional way they are usual ly represented.
In general a detail belongs to a structural surface where it is moun ted (profile) or it divides the panel (seam). Thus it follows **the** - way of surface representation which is usually done over three con- ventional views:

- transversal view from aft to fore (web frames, transversal bulkhe- ads, floors ecc.);
- longitudinal view from starboard side (longitudinal bulkheads, gir- ders ecc.);
- longitudinal view from top (decks, tanktops, forecastle, etc.)

PRINTS AND TABLES

Another important peculiarity of the system concerns the signifi- cant offset tables of the whole structure representing its numeri cal image and an auxiliary medium in design activities.
These offsets are very useful both for checking purpose and for valid documentation of the various offices. They are mainly obtai- ned during input operation, or separately whenever they are demanded.

Body plan offset

The module supplies, frame by frame, on offset of the body plan at any section of horizontal (WL) and vertical (BT) plane, inclu- ding tangencies and kunckles.

Details offset

The module supplies significant information on the spatial extension and detail orientation of one or more groups of details belonging to one or more structural surfaces.

As far as profiles are concerned and during input operation the relative modules print some relevant production information like the raw or net lenght, scantling, type of ending (snipe, butt or overlapping).

DRAWING FUNCTIONS

A vital role in design phase and production is played by the different drawings representing the actual structure as a spatial object.
The system meets these demands since it is capable of furnishing a set of drawings which are comformed to the different representations of the structure at different levels of storing. Graphical outputs and their completion depend on the quantity of input which has been performed. What has to be pointed out is that the actual output does not depend on the wanted structure only, but also on the adjacent delimiting or penetrating structures which determine, in that very moment, the actual boundaries and the necessary contrast in the drawing.
Drawings can be obtained over the complete structure or part of it (windowing).
Graphical outputs can be conveyed on every kind of graphical devices. either flat and drum drawing machines or storage and refreshed CRT.

Body plan drawings

Drawings of body plan concerning transverse frames, waterlines, but toks, and other longitudinal curves are obtained during FORAN of BOF operation.
This module supplies drawings of body plan with additional waterlines or buttocks. They are useful for manual completion of body plan extremities (when they are not faired enough).

Shell structure drawings

The module expands and furnishes several levels of drawings of the body plan completed with seams, profiles and connected structures.
In particular it furnishes:
- shell expansion plan, and connected structures
- shell expansion plan including butts and seams only
- transversal body plan comprehensive of traces of the internal structure
- transversal body plan comprehensive of longitudinals, seams and butts traces at shell including profiles section; orientation and tangencies.

Inner structure drawings

The whole internal structure is graphically represented by this module which is capable of generating drawings over the various extensions and conventional views of the hull.

INTERNAL STRUCTURE GENERATION

About sixty per cent of parts of the internal structure are today generated by ALKON module, supported by ALKON norms and by new ALKON commands developed by ITC.
The remaining parts and all the, profiles are generated by the output modules of the system or manually (rectangular plates).

Collar plate generation

The module generates the collar plates over the structure they are later associated to.
Production data as bevels, weight, minimum scrap of material, are also furnished.

Simple plate generation

Most of the panels plates are often defined as a rectangular or as a simple poligonous. They are usually generated manually (repetitive pieces) or by means of this module which works over the seams, inner contours, and simple derived contours handled by the system.

Profiles generation

The module expands and transfers element information and its relation into an appropriate file.
It operates over the information stored in a previous phase.
Missing information can be associated in this phase to complete an existing profile or to generate a new one.

SHELL STRUCTURE GENERATION

This operation is performed by three modules including the one which supplies templates for rolling and bending purposes.

Shell plates expansion

The module expands any type of shell plates (apart from the very shaped plates situated at the extremities) either they are simple, double, or partially curved or they are longitudinally and vertically arranged. They are expanded with a new method (mosaic method) which assures the highest precision.
Output of this module can be Summariezed as follows:
- expansion calculation takes bending effect and welding shrinkage into account;
- to be aware of correctness the User is warned of the results of expansion and he can influence such results by further processing of not satisfying output;

- paper tape for 2 or 3-axis flame cutting machines including punch marking or flame tracing contour;
- rolling line or tangency are part of marking contour;
- cheching data to be used before or after the plate is rolled or bended;
- minimum rectangular plate and data for evaluation of bending and heating.

Shell profiles expansion

The module expands either longitudinal frames or transverse frames at shell. Paper tape for drawing and relevant production information are supplied as described below.

- Scantling of profiles are fetched from previous storing and expansion is computed over the barycentric line.
- Repetition makes it easy to fill up forms.
- Notches and holes can be included.
- Butts or endings in standard version or upon user's request.
- Bending evaluation, marking and hand-cutting information.
- Web plates which have to be cut from plates are transferred into the AUTOKON Data Base for further nesting.
- Bending table is automatically obtained for a group of profiles and constitutes document A9 furtherly described.

Templates of shell structure

Templates for shell structure bending are built over the information supplied by this module.
Such information is given either in the form of tables or paper tape for templates drawing.

SHELL STRUCTURE FABRICATION AND OUTFITTING

Shell block erection

The module supplies several technical and production information which are essential during the delicate phase of shell structure erection.
Panel can be arranged prevalently horizontally or angles of rotation can be forced.
Going through the entire phase of structure erection the following information are supplied:

- actual drawing of the panel and traces of the internal structure;
- boundaries of the panel referred to the platform;
- corners of shell plates spatially referred;-
- panel marking and checking data, mounting angle of profiles;
- mounting angle either for transversal and longitudinal structures;
- significant data to check boundaries and structures after welding.

Painting lines table

The module computes and supplies information to trace painting lines along the shell surface.
For each T-frame both height from base line and arclength from the nearest seam are supplied.

Draught Marks

The module expands draught mark numbers and supplies drawing of developed numbers and production information:
- four types of draught marks are provided;
- cutting and welding contours;
- templates to mark levels of numbers.

WORKSHOP DOCUMENTATION

The documents concerning one or more units are fundamentally grouped in:
A) documents for processing raw and finished materials
B) documents for handling raw and finished materials.

General basic list

All information concerning a lot and distributed on the various out puts, derives mainly from a general basic list, whose programs are integrated in the hull system.
Lot by lot, unit by unit, and subassembly by subassembly, all consisting parts are taken into consideration.
The output is utilized in a successive phase to obtain the workshop documentation necessary for work performance.

Most significant aspects of some documents, automatically supplied by the system

Document type "A"

Document "A1" - It is the document which is attached to the punched tape for the N.C. cutting machines. It shows all indications necessary for the operator and the marker of the cut parts. It represents the graphic result of the part nesting operations. Representation is made on 1:20 scale.
Document "A2" - It represents the result of the "N.C." cutting operations concerning the lot.
Lot by lot and for each cutting scheme the document gives relevant information.
Basing on such data, we plan the work loads of the N.C. cutting machines.

Document "A3" - It represents the cutting scheme for the parallel cutting machines.
Document "A4" - Similar to document "A3", it is used to obtain flat bars from plates.
Document "A5" - It represents the cutting scheme for pantograph and shears.
Document "A6" - It concerns the schemes for manual marking of hole notches on profiles.
Document "A7" - For description of bending or curving operations subsequent to plate marking.
The document is used by the pressing machine, rolling machine, and flanging machine.
Document "A8" - It concerns manual marking, cutting and handling of profiles. This document is obtained as output of program "Hull general basic list"; the input data are fetched from AUTOKON Data Base and handled by the program.
Document "A9" - This document gives the characteristics of the profile pieces to bent it, with full information for its completion.
Document "A12" - It represents the final document of the "cutting scheme for profile " made by computer.
Document "Al5" - This is the basic document for assembly purpose during prefabrication of the parts processed in workshop.
Being a drawing document it is manually completed.

Document type "B"

Document "Bl" - This is the program for steel plates feeding subdivided in:
- plates intended for N.C. cutting
- plates of shell intended for N.C. cutting
- plates intended for parallel cutting
- plates to be cut by pantograph
- plates to be manually marked.

The main information given are:
- lot number
- cutting scheme number
- raw material
- painting
- sizes of raw piece to be cut
- material quality.

Document "B2" - This is the program for profiles, feeding the workshop subdivided in:
- profiles to be marked and cut
- profiles to be directly dispatched to small prefabrication
- profiles to be directly dispatched to big prefabrication-
- profiles to be bent and then intended for big prefabrication
- profiles to be bent and then intended for small prefabrication.

Document "B3". - This output shows the detail of the pieces obtained from plates described under "Bl". It indicates for each cutting scheme:

- pieces to be obtained
- subsequent processing work, if any
- working area, block and subassembly.

Please note that "A8" has the same function as "B3" for profiles.

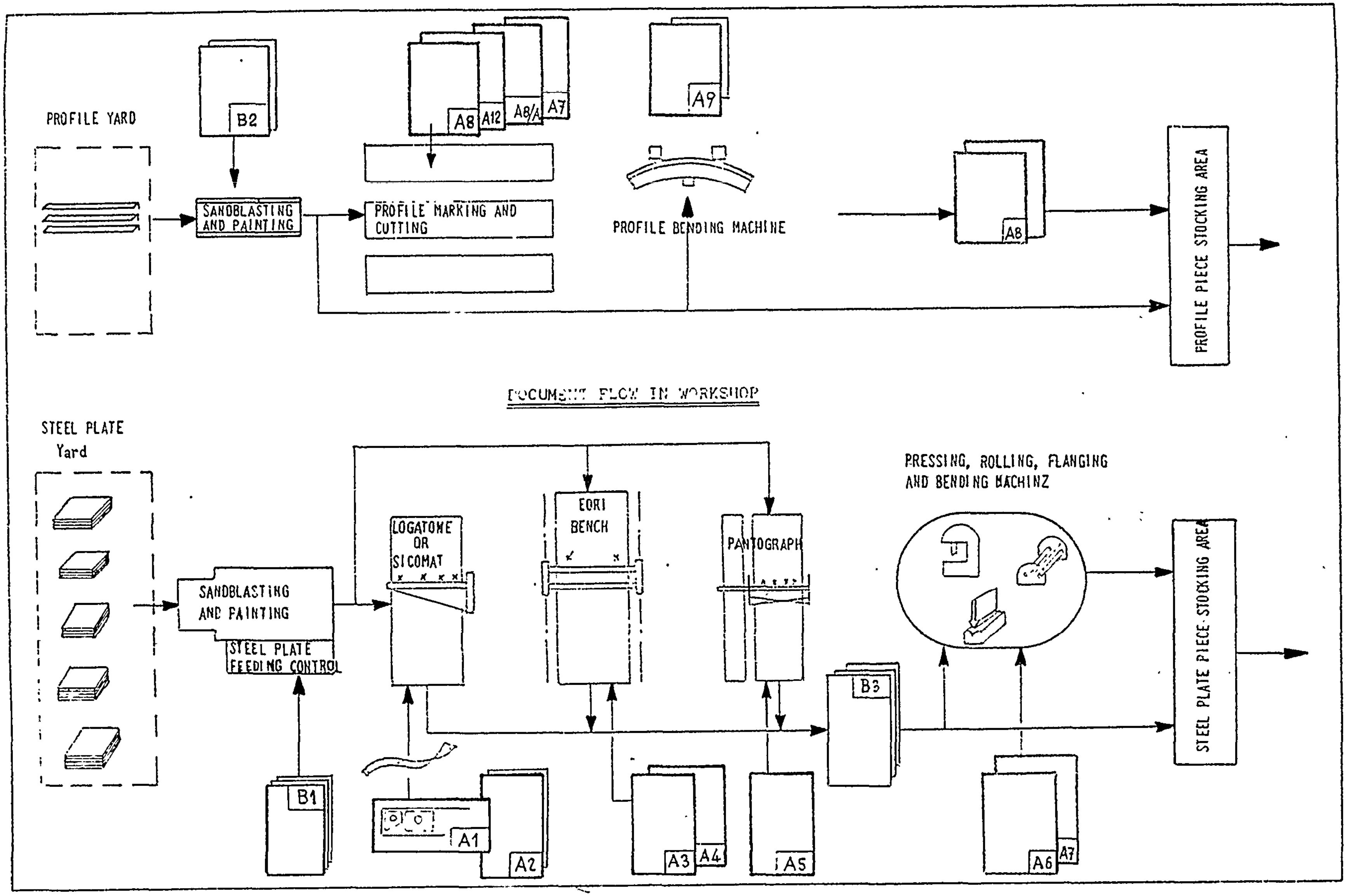
Document "B4" - It integrates "A15", as it gives the composition and the weight of the represented subassemblies.

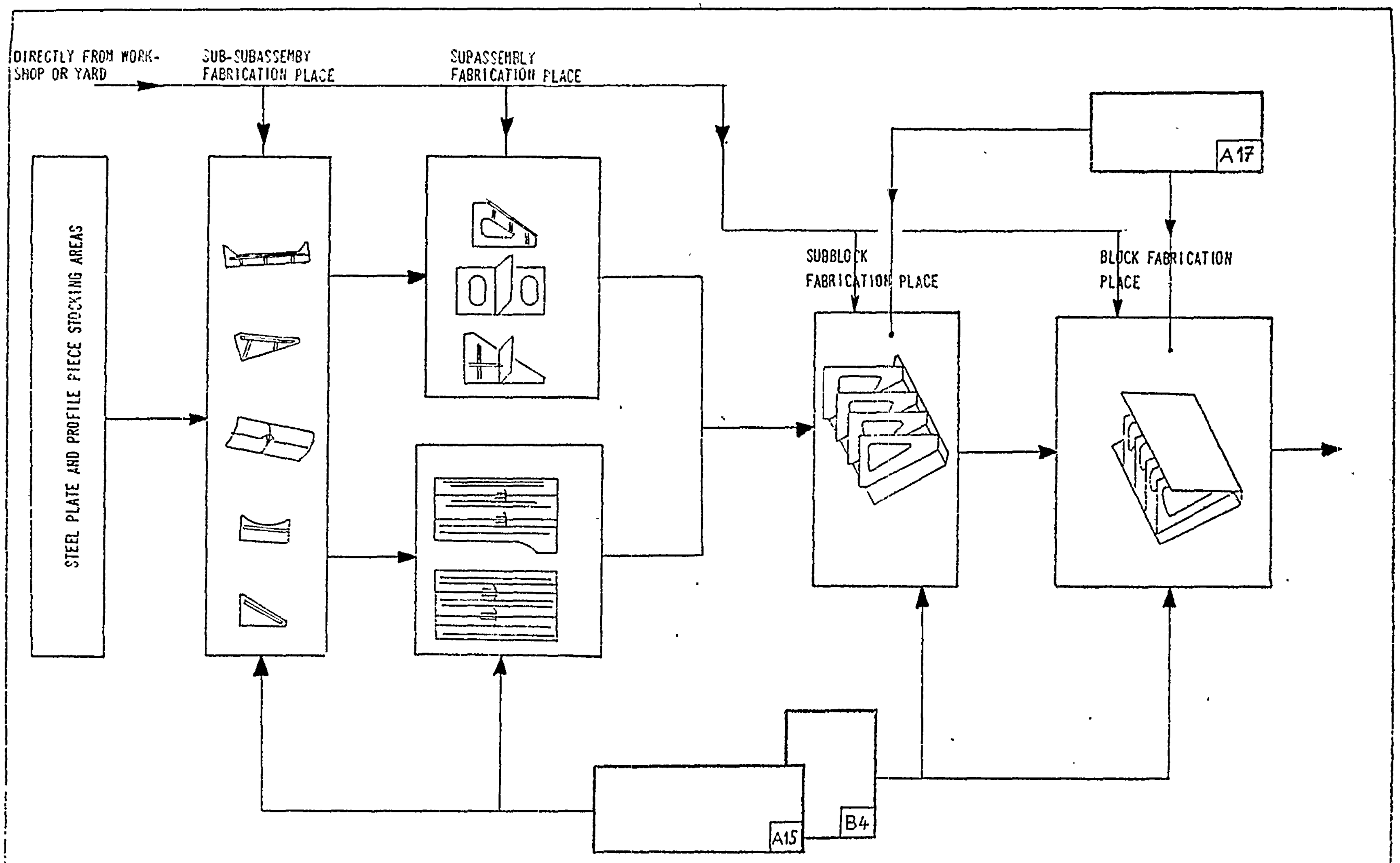
The following figures show the manufacturing phases where above documents are utilized.

REFERENCES

R. Di Luca, E. Bais: SCAFO, a CAD and CAM integrated system, from basic design to assembly.

ICCAS '79.


PROFILE YARD
B2
A8
A12
A8/A
A7
A9
SANDBLASTING AND PAINTING
PROFILE MARKING AND CUTTING
PROFILE BENDING MACHINE
A8
PROFILE PIECE STOCKING AREA
DOCUMENT FLOW IN WORKSHOP
STEEL PLATE Yard
SANDBLASTING AND PAINTING
STEEL PLATE FEEDING CONTROL
LOGATOME OR SICOMAT
EORI BENCH
PANTOGRAPH
PRESSING, ROLLING, FLANGING AND BENDING MACHINZ
B3
STEEL PLATE PIECE STOCKING AREA
B1
A1
A2
A3
A4
A5
A6
A7



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